# The Moderating Effect of Physical Activity on the Relationship between Sleep Quality and Depression among Male College Students

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## Abstract

The moderating role of physical activity in the association with both sleep quality and depression has not yet been thoroughly examined among college students. The study aims to investigate how physical activity may adequately link the relationship between sleep quality and depression among male college students. This quantitative study involved 139 male college students aged 18 to 26 from the University of Sulaimani (UOS), Kurdistan Region, Iraq. A convenience sampling method was employed, and the public university was selected randomly. Descriptive statistics were computed using SPSS software, and data were evaluated with Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicated a negative and significant relationship between subjective sleep qualities, sleep duration, and efficiency of sleep with depression. At the time, depression was positively associated with sleep disturbances plus daytime dysfunction. These results also showed that there was no significant connection between sleep latency and the use of sleep medication for depression. These results found that physical activity moderated the relationship between subjective sleep quality, daytime dysfunction, and the use of sleep medication. At the same time, it had no significant moderating effect on the relationship between other components and depression. These findings emphasize the role of physical activity in the relationship between sleep quality and depression for this population. The results revealed that the proposed, tested conceptual model is applicable, reliable, and usable for male college students. It is believed that the outcome of this study will underscore the importance of executing physical activity in the relationship between quality of sleep and depression.

**Keywords: Physical activity, Sleep quality, Depression, Male college students.**

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# 1- INTRODUCTION

Physical inactivity (PA) is one of the significant public health issues worldwide, and it is the fourth most common behavioral risk factor that causes several non-communicable diseases like heart attack (cardiovascular disease and diabetes). Adequate PA is defined as engaging in greater or equivalent to 150 minutes of moderate-intensity activity or less than or comparable to 75 minutes of vigorous-intensity activity per week or an equal amount of the combination of both (Elshahat & Newbold, 2021). During this time, people are developing rapidly so that they may be ready for adulthood. Academic years are the stints where individuals try to end their development quickly and, as such, learn a profession they would carry out for the rest of their lives. It is, therefore, common among learners to lose some weight to excel academically, decreasing social life departures (Bulguroglu et al., 2023). College students are a unique group that passes through a phase full of difficulties, dangers, and social maturity transitions. There is evidence from other research to show that college students across the world usually have very extraordinary degrees of psychological illness, such as depression and concern. Besides, this group was also found to exhibit a higher percentage of sleep disorders (Roeper et al., 2023). Inadequate sleep may be linked with negative aspects of one's life, such as poor mental health, level of productivity, and quality of life. As such, it is recommended that healthy sleep habits be promoted among students to prevent them from experiencing these problems (Suardiaz-Muro et al., 2023). According to various research, adolescents' sleep withdrawal complications are likely to be a significant dangerous element for their psychological well-being disorders (Feng et al., 2014; Becker et al., 2018). A robust relationship was discovered by scientists on college students between their SQ and a higher likelihood of depression (Yang et al., 2023).

As recent research argues, the health and academic performance of college students are heavily impacted by frequent depression episodes (Sud et al., 2024). Additionally, different research works have consistently indicated that the signs of depression are associated with a lack of sufficient sleep (Huang et al., 2024). Sleep disturbances usually affect college students more because of the way they live, socialize, or do their academic work (Wang et al., 2023). It is confirmed by research that physical activity could affect depression and sleep positively. The investigation has reported a relationship between regular exercise, decreased depression, and enhanced sleep quality (Zhang et al., 2024). Although there are established links between depression, physical activity, and SQ, little research has been done on how these factors interact when it comes to male college students. In particular, not enough research has been done on how PA affects the link between depression and SQ. Determining whether exercise might mitigate the detrimental effects of sleep deprivation on depression symptoms could have significant consequences for designing focused therapies. The current studies are missing adequate attention on how moderating PA influences the connection between sleep quality and depression. Especially in the Middle East, this type of research needs to be given closer attention. Extremely insufficient research focused on the association between these factors, notably among male college students. This study aims to approach this gap by exploring a new model that examines the moderating effect of physical activity on the relationship between sleep quality and depression among male college students. By investigating these factors concurrently to develop more potent preventative and treatment plans, the study aims to give a more thorough understanding of their integrated effects on mental health.

## 2- LITERATURE REVIEW

A previous study conducted in China investigated the levels of anxiety, depression, and SQ in college students post-COVID-19 and examined the moderating effect of PA. The study found significant levels of anxiety and depression with poor SQ among students, notably that PA was found to moderate these effects positively. However, The study's limitation is its focus on an explicit demographic (Zhang et al., 2024). This research explored how physical exercises influence moods and Sleep Quality (SQ) in China through COVID-19. Generally, the results suggest that participants' moods and SQ were positively influenced by doing physical exercises. However, there has been a limitation because the study was concentrated within a unique setting like the COVID era, making it non-generalizable (Han, 2024). To investigate the association between SQ and PA, depressive symptoms of rural university students were studied in China. Research indicates that higher levels of depressive symptoms were associated with lower PA and poorer SQ. Additionally, the interaction effects indicated that good SQ combined with moderate PA was associated with reduced depressive symptoms. A notable limitation of this study is its focus on rural students; This might restrict the results from broader application to other population groups (Yang et al., 2023). Previous studies found the frequencies and what influences them of PA, and among Indian college students, depression considerably influences the sleep of college students. The study demonstrated that greater physical activity and better sleep quality are associated with reduced levels of depression. Factors, namely gender identity, smoking, and alcohol intake, also affected the results. Moreover, the research's outcomes have restricted applicability (Alam et al., 2023). Prior research among Chinese college students investigated the relationship between physical activity, sleep, and depression. This study revealed that a decreased level of depression was connected to better sleep quality and greater PA. Nevertheless, it did not examine PA as a moderating factor (Cahuas et al., 2019).

However, none have been conducted in the Iraqi context. In Iraqi society, specificity is essential as far as the outcomes from studies are concerned; this is due to the differences in the study's location, the group of individuals being studied, the research design used, and the sampling methods applied. However, only one of the previous studies was conducted in the Middle East (Bulguroglu et al., 2023). None of the earlier publications have touched on the affiliation model between PA, SQ, and depression among male university students. Additionally, this limitation highlights the issue of restricted generalizability and underscores the need for research specifically targeting male college students within the Iraqi context.

### 2.1 THEORETICAL MODEL

The Sleep-Affect Model (Sleep-Wake Model of Depression): The Sleep-Affect Model, developed by Michael T. Bowers and William P. C. W. Silver, is a theory that directly discourses and supports the affiliation between SQ and depression. To understand how poor SQ contributes to the beginnings and long-term persistence of sadness symptoms, a thorough framework is provided by this model (Luo & Lin, 2024; Luo et al., 2024; Otte & Carpenter, 2009). The model is specific in detailing how an imbalance in poor SQ sets the stage for higher levels of depression-like irritability, stress as well as mood swings. Conversely, depression leads to disturbed sleep as a result of either lack of or excessive sleep, aggravating the symptoms of depression to create a self-propagating cycle. This underscores the model's importance in managing and preventing depression by addressing sleep and mood (Luo et al., 2024; Luo & Lin, 2024). Therefore, the Diathesis-Stress Model states that stress may activate or worsen mental disorders in a person. Physical exercise may help lessen

strain and decrease poor sleep from increasing depression (Monroe & Cummins, 2015; Turk, 2002). Also, physical activity can reduce mental stress by mitigating the adverse effects of stress, personal pleasure, and other emotions, which helps prevent depressive sleep dissatisfaction. (Raffaelli et al., 2013)and Giessing et al., 2021). In addition, the biological, psychological, and social models often overlap, as they propose that physical exercise positively affects a person's mood and sleep quality. Therefore, exercise may change how good sleep is related to depression through its influence on multiple health domains. In essence, it is through these propositions that exercise acts against decreased sleep quality's adverse effects on psychological health, thus modifying the linkages between depressive symptoms and disturbances in sleep type that have been observed among individuals with major depressive disorder (Lehman et al., 2017;  John et al., 2020).

## 3- HYPOTHESES OF THE STUDY

Earlier research findings indicate a substantial relationship between these variables, which supports the current study hypothesis. Our study aims to assess this association as reflected in previous studies or results that have not been adequately investigated.

The study conducted earlier established a direct relationship between high levels of depression and longer sleep latency, which implies that people who have severe depression spend more time awakening at night before falling asleep (Omichi et al., 2022).

**H1:** Within the MCS population, there is a positive correlation between sleep latency and depression.

The evidence from prior research supports that depression is more prevalent among university students who sleep frequently for short periods. Notably, Zhang et al. (2023) found out through their study that (Li et al., 2020) shortening sleep hours could cause increased distress in people.

**H2:** Among MCS, depression has a negative relationship with sleep duration.

Our lab has found that varying patterns of daily sleep efficiency are a robust predictor of depression severity. Specifically, when people cannot sleep relaxed throughout the night with fewer awakenings or moving around too much in bed while struggling to fall asleep, there is lower mood expressed or greater levels of depression experienced eventually.

**H3:** Among MCS, sleep efficiency is negatively connected with depression.

The positive association between sleep disturbance and mood problems has gained enough attention from researchers (M Salih et al., 2023; Barsha & Hossain, 2020), suggesting that high levels of depression may be expected for cases of severe or chronic sleep disruptions.

**H4:** Sleep disturbances are positively associated with depression amongst MCS.

There is evidence that there is a correlation between taking sleep medicine and getting depressed (Chery et al., 2024). It would, therefore, be logical to expect that increased use of sleep remedies results in increased depression  levels.

**H5:** Practicing sleep medication is positively associated with depression amongst MCS.

According to the literature, people who have severe daytime dysfunctions often have more heightened feelings of depression (Shim et al., 2019). Therefore, it is predicted that people who encounter more difficulties concentrating, feeling energetic enough to work, or being productive could also suffer from worse levels of depressive symptoms as well.

**H6:** Daytime dysfunction is positively correlated with depression among MCS.

The study confirmed previous findings that there was a strong link between being depressed and getting a bad night's sleep. (Huang et al., 2016; Gerri Satvik Emmanuel and Lokesh L, 2024). That suggested lower subjective SQ would be connected to elevated depression rates.

**H7:** Subjective quality of sleep is negatively correlated with depression among MCS.

Studies have shown that there is a strong relationship between PA and the correlation between SQ and depression (Djajadisastra & Batterham, 2024). In essence, this shows that one's level of depression may determine how good or bad their sleep can be. For instance, engaging in regular PA may improve overall SQ or lower the depression level.

**H8:** PA moderates the relationship between SQ and Depression among MCS.

## 4- METHODS AND MATERIALS

### 4.1 Procedure

The Committee on Ethics of the College of Physical Education and Sport Sciences at the University of Sulaimani accepted this study, permitting each student to decide upon their participation according to only their preference, devoid of any assurances concerning personal or institutional benefit. Besides, before participating in the study, those who participated were provided with written instructions regarding their rights and the study procedure; consequently, they were permitted to withdraw at their discretion. As the researcher is a lecturer at the same university, written permission was unnecessary due to the retrospective nature of the data collection and the anonymity that was maintained. Consequently, the researcher had permission to acquire data without obtaining prior permission from the University of Sulaimani. The proposed plan for proceeding was based on Helsinki's declaration in 1964, which was last assessed in Fortaleza, Brazil, in 2013.

### 4.2 Participants

The participants in this study were selected by the G*power software that was utilized to figure out the collective sample size necessary for the research model. This software includes nearly every form of analysis evaluation and provides a variety of functions and options. This software is a method that is commonly used in scientific research to determine the necessary sample size for a given number of hypothesis (Kang, 2021). The sample size for eight predicted hypothesis was 74, as calculated by the G*power software. The study was carried out from May 4 to May 21, 2023, at the University of Sulaimani in the Kurdistan region of Iraq. The study involved 139 full-time male undergraduate students from the 1st to the 4th years, aged between eighteen and twenty-six years, with an average age of 20.31 years (SD = 2.07). Measurements of Sleep quality,

depression, and physical activity were administered to all student participants to confirm the validity of the evaluation instruments and the cognitive abilities of the students. Furthermore, Data were included only from students who provided complete responses. The analysis excluded responses that did not provide the necessary information. For instance, participants were selected randomly from every faculty except the college of Sport Science and Physical Education, which has unique physical education classes. For instance, students in the College of Sport Science take different physical exercise classes, which could make them different from those in other faculties.

### 4.3 Instrument

#### 4.3.1 Physical activity

The short version of the self-administered International Physical Activity Questionnaire (IPAQ) was used to assess PA. It has a Cronbach's alpha value of around 0.70, signaling high reliability. Among university students, the IPAQ-S7S is considered a reliable and valid measure of PA (Dinger et al., 2006). It measures how much time someone has spent engaging in physical activities during the previous 7 days, taking into account their frequency, duration, and modes when they walk, performing moderately intense or vigorously intense ones lasting at least 10 minutes each time. Different from each other ways of estimation, for global ranks of physical activity for each person, we modified IPAQ data handling strategies already described by other authors (Craig et al., 2003). An approach also involved eliminating cases found in all three PA domains. To calculate the total hours spent walking in a week, including moderate and heavy activities, one must find products of the days each category is engaged in and average daily times. These estimates are derived based on energy costs of various intensities, starting with METs (metabolic equivalents) scored for low (3.3 METs), medium (4 METs), and high (8 METs) pace exercise levels applied to time spent in different intensity categories per week. Consequently, people can be classified as having low or high PA levels depending on how much they engage themselves physically. Your moderation standards can be found at http://www.ipaq.ki.se, often indicating that "moderate" means at least 30 mists of reasonable power physical movement on 5 existences per week, enthusiastic activity being 20 min on 3 days or both combined when "moderate" is mentioned on their site. Categorization: low: meets none of the "moderate" and "high" criteria. Moderate category is defined as reaching any one of these three options: (a) At least 3 days of intense physical activities for not less than 20 min/day; (b) For periods exceeding 10 min and total remaining 30 minutes/day, walking or moderate intensity activities during 5days; or (b) For 5 consecutive days, walk, or engage in moderate or vigorous activities totaling 600 MET-minutes/week. High: refers to meeting any of these: (a) Doing vigorous activities over 3 days per week and adding 1500 MET-minutes, or (b) Walking for more than 3000 MET-minutes or doing a combination of moderate-intensity exercise.

#### 4.3.2 Sleep Quality

The quality of sleep was assessed using PSQI, regarded as the most frequently used survey on SQ in research and clinical practices. The Cronbach's alpha coefficient was 0.83. PSQI has been validated as a reliable measure of SQ among various clinical and non-clinical populations (Mollayeva et al., 2016; Wolf & Rosenstock, 2017). Furthermore, it has been shown that the PSQI is valid even in small samples (Mollayeva et al., 2016). A self-report questionnaire containing 19 items aimed at evaluating SQ during the past month was developed by Buysse et al. (1989). The components that make up the PSQI include subjective SQ, sleep latency, total sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction; therefore, each item varies from 0 to 3. An overall sum score out of 21 can be obtained by adding individual scores from all

sections together such that higher scores imply poorer SQ.

### 4.3.3 Depression

The Zung Self-Rating Depression Scale (SDS) (Zung, Richard, & short, 1965) was utilized to measure depressive symptoms in this study. It has Cronbach's alpha value of around 0.79, which is agreeable. Many Chinese scholars use it for diverse populations (Li et al., 2020; Lee et al., 1994). It also suits university students on this scale (Shao et al., 2020; Nie et al., 2017). The self-administered SDS can measure the severity of depressive symptoms. Evaluative of four core dimensions, namely, anxiety, cognitive, somatic, and core depressive, by 20 items is the original scale (Dunstan & Scott, 2019; Kirkby et al., 2005). The SDS for this study was culturally adapted to suit the context of Iraqi society. The removal of one of the items associated with feeling pleasure during sex was quite sensitive and could have been culturally inappropriate. Such a change intended to help it become more accurate, especially when assessing depression among Iraqi people, while at the same time making sure that it remained acceptable to them. This adaptation contains 19 items. The fourteen standard items were retained in this modified version, but another five were added for various purposes, including determining whether someone has difficulty falling asleep (e.g., "Do you have trouble falling asleep?"). The scale has items concerning both negative and positive experiences, with reverse-scored items for positive experiences and the rest for negative experiences (e.g., "I feel down-hearted and blue" and "I eat as much as I used to eat"). Respondents then were asked to rate the extent to which each statement was descriptive of their experiences in the past week. Responses were given on a four-point Likert scale for negative items, while positive items were on a reverse Likert scale. Answer options for the negative items will range from 1 (some of the time) through 4 (most of the time). In the positive items, the rate of responses varies, going from 4 ( some of the time) to 1 ( most of the time). The scores were obtained by adding up all the numbers of these 19 items, which could indicate how depressed one happened to feel during that period. The values range between 25 and 100, and high values denote high levels of depressive symptomatology; those below 50 are considered normal.

### 4.4 Data collection

The standard back-translation method was used during language translation (Maneesriwongul & Dixon, 2004). The depression, SQ, and PA scales were translated into the Kurdish language. In order to complete this phase, the translation required the assistance of three separate bilingual translators. The first expert translator translated the English text into the Kurdish language. In order to ensure uniformity and accuracy, the second bilingual specialist translated the Kurdish text into English. Additionally, a third expert has also used the reliability of content as a method of evaluation by experts to confirm the instrument's validity and guarantee that the translation accurately reflects the initial concept. For proper translation, the translator should have command of these two languages and the subject matter of this instrument (Sousa, 2011). Based on this process, the scales were considered appropriate and sufficient for the translation process of Kurdish; the scale was eventually created in Kurdish.

## 5- STATICAL ANALYSIS

First, the producer of data analysis began with the coding of variables and questions. This was followed by data cleaning and preparation to identify missing data, detect suspicious response patterns, perform normality tests, and detect outliers using the Statistical Package for the Social Sciences (SPSS) software, version 29. After the data cleaning phase was complete, the researchers created descriptive statistics for the continuous

variables by computing both means and standard deviations, and they conducted frequency analyses for the categorical variables. Their approach to testing the assumptions and constructs of the theoretical framework was via SmartPLS Software v4.1.0.6, a Structural Equation Modelling tool. This was undertaken to validate the measure and the path model, and it conformed to the research objectives, which concentrated on predicting and explaining the differences among constructs. Known for its robustness in modelling predictive hypotheses and PLS-structural Equation Modeling (SEM), SmartPLS thus offers more advanced capabilities. It has attributes such as its friendly predictive PLS predict measure, an easy-to-understand interface, robust model fit assessment grounds, and highly effective data handling capacities. Therefore, this tool is more appropriate for intricate models and accurate forecasts required in various fields, including but not limited to online advertisement and software engineering, according to (Cheah et al., 2024).

## 6- RESULTS

### Sample Age

Upon analyzing the data, it was found that boys attending university fell within the age bracket of 18 and 26 and were of a mean age of (M=21. 57, SD=1. 93).

**Table 1** Results of descriptive analysis for age

| | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| **Age** | 18 | 26 | 21.57 | 1.93 |

The results for student's physical activity showed that 54% of students had low physical activity, 29.5% of students contributed moderate physical activity, and only 16.5% had high physical activity (Figure 1).

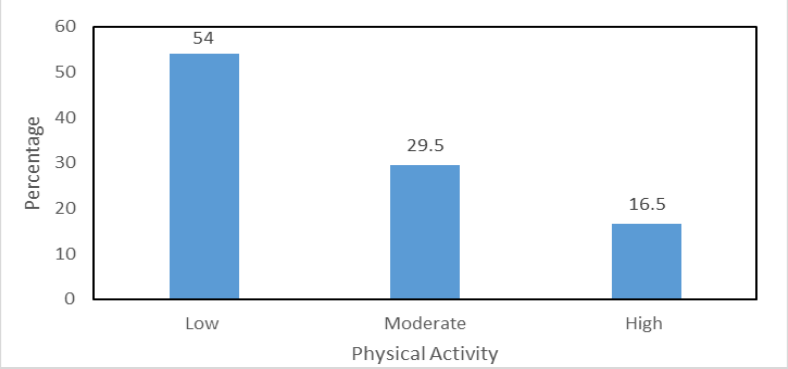


**Figure 1.** Distribution of physical activity among students

### Sleep Quality

Seven different aspects comprise the subjective SQ, sleep latency, total sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction. Several scales were used to assess the first four domains, whereas a similar scale was used to assess the last three domains.

Concerning sleep latency, it was revealed that the largest percentage of students had a sleep latency between 16 and 30 minutes (40.3%), while the second largest percentage of students had a sleep latency of 30 minutes (38.8%). For the second, sleep efficiency, it was seen that most of the students were in the range of 75 to 84 percent (46 %), and only 13.7% percent of the participants had above 65% sleep efficiency. With regard to sleep duration, it was found that 38.1% of the students slept for less than 5 hours, while 33.8% slept for between 5 to 6 hours. 42.4% of the students claimed to have fairly good SQ, and 15.8% stated they had very good SQ. On the other end of the scale, 16.5% of the students described their SQ as extremely bad.

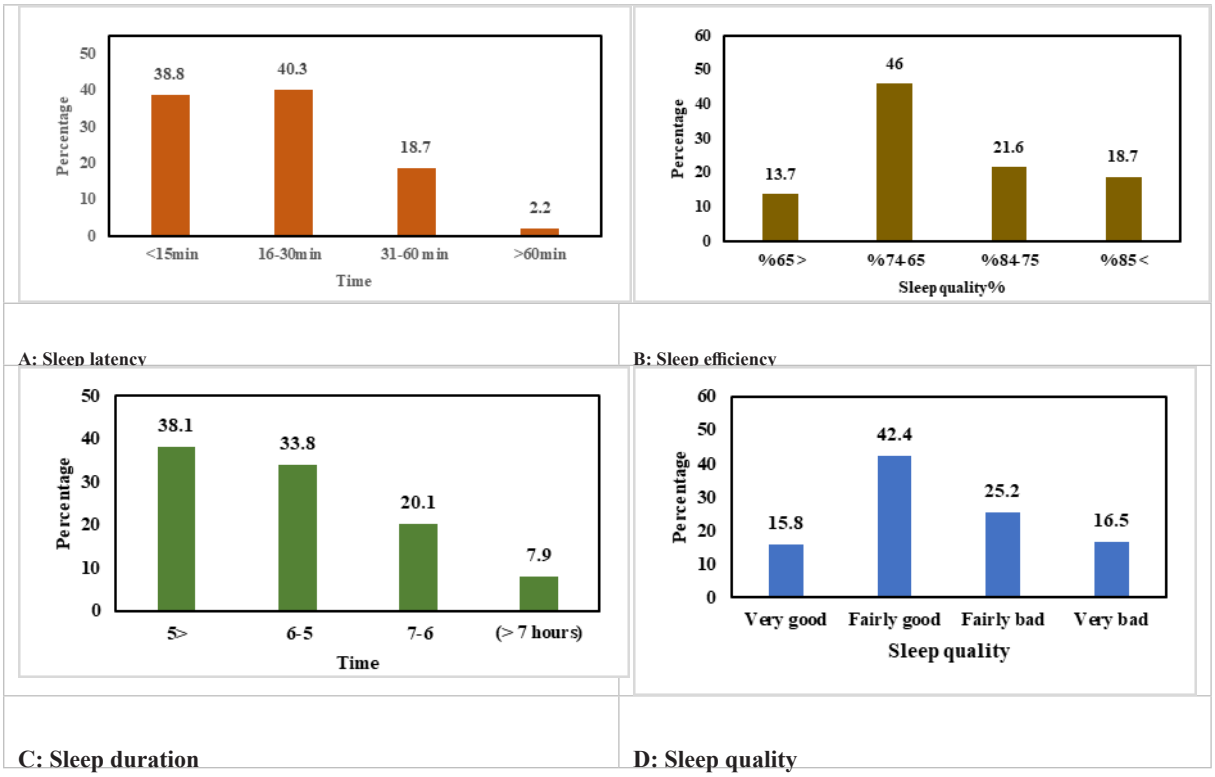


**Figure 2.** Distribution of students respond to sleep latency, sleep efficiency, sleep duration, and sleep quality

According to these results (table 2), it was found that for daytime dysfunction, 58.3% of students reported that they had no difficulties keeping awake when driving, eating meals or socializing. However, keeping enthusiasm is a challenge for 54% of students, which indicates that they struggle with this (more than once or twice per week). Results showed that the use of sleeping medication was relatively low among the students. Most students (87.8%) said they did not use sleeping medicines for one month or less than once a week.

**Table 2** Frequency distribution of students' response to sleep disturbances, daytime dysfunction and medication use.

| Domain | Item | Not during the past month | Less than once per week | Once or twice per week | Three or more times per week |
|---|---|---|---|---|---|
| Sleep disturbances | Cannot get to sleep within 30 minutes | 16.5 | 36.7 | 18.7 | 28.1 |
| | Wake up in the middle of the night or early morning | 28.8 | 23.7 | 27.3 | 20.1 |
| | Have to get up to use the bathroom | 18.7 | 27.3 | 25.9 | 28.1 |
| | Cannot breathe comfortably | 13.7 | 35.3 | 23.7 | 27.3 |
| | Cough or snore loudly | 13.7 | 38.1 | 12.9 | 35.3 |
| | Feel too cold | 20.9 | 34.5 | 22.3 | 22.3 |
| | Feel too hot | 10.8 | 36 | 28.8 | 24.5 |
| | Have bad dreams | 7.9 | 28.1 | 49.6 | 14.4 |
| | Have pain | 10.1 | 18.7 | 36.7 | 34.5 |
| Daytime dysfunction | During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? | 15.1 | 43.2 | 26.6 | 15.1 |
| | During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? | 13.7 | 32.4 | 36.7 | 17.3 |
| Sleeping medication | Use of sleeping medication | 55.4 | 32.4 | 9.4 | 2.9 |

## Depression

The results of descriptive statistics for depression domains (anxiety, cognitive, somatic, and core depressive symptoms) are presented in Table 3. According to these results, the highest mean score belonged to the core cognitive component with a mean score of M= 2.248, SD=0.759, followed by the core depressive domain, which shows a mean score of M=2.239, SD=0.754. It was found that the lowest mean score was observed for

anxiety, with a mean score of M=2.148, SD=0.774.

**Table 3** Results of descriptive analysis for depression scale

| Sub-domain | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Anxiety | 1.00 | 4.00 | 2.148 | 0.774 |
| Cognitive | 1.00 | 4.00 | 2.248 | 0.759 |
| Somatic | 1.00 | 4.00 | 2.223 | 0.820 |
| Core depressive | 1.00 | 4.00 | 2.239 | 0.754 |

## First-Order Model

The measurement model was evaluated for depression, which was a second-order construct with four sub-domains, and all other variables in this research were considered single items, including physical activity and seven domains of SQ. The results (Table 4) demonstrated that all subscales of depression (anxiety, cognitive, core depressive, and somatic) possess a high level of convergence invalidity. All of the items had a satisfactory loading factor, as revealed by the results. (i.e., greater than 0.5). The research suggests that the composite reliability (CR) and alpha Cronbach were found that the heteroscedasticity test had an R square value above 0.7 while the average generic extracted gradient passed tests set at 0.5. It was noted that the heteroscedasticity test had exceeded the threshold set by HTMT developed by (Henseler et al., 2015), so it is imperative to ensure discriminant validity.

**Table 4** Convergent validity and reliability assessment of measurements

| Construct | No items | Loading | Cronbach's Alpha | CR | AVE |
|---|---|---|---|---|---|
| **Anxiety** | 3 | 0.747- 0.835 | 0.696 | 0.831 | 0.621 |
| **Cognitive** | 4 | 0.707-0.809 | 0.787 | 0.862 | 0.610 |
| **Core Depressive** | 7 | 0.770-0.832 | 0.902 | 0.923 | 0.630 |
| **Somatic** | 3 | 0.846-0.875 | 0.826 | 0.896 | 0.742 |

## Second order assessment

Since depression was a second-order construct, therefore bootstrapping was used to evaluate the second-order model for this construct. Results (Table 5) show that the four sub-dimensions of depression including anxiety ($\lambda$ = 0.794; p < 0.001), cognitive ($\lambda$= 0.715; p < 0.001), core depressive ($\lambda$ = 0.954; p < 0.001), and somatic ($\lambda$ = 0.820; p < 0.001) significantly contributed to depression as a second-order latent variable.

**Table 5** Second-order assessment of measurements using Bootstrap

| First order | Loading | SE | T value | P Values |
|---|---|---|---|---|
| Anxiety | 0.794 | 0.034 | 23.401 | <0.001 |
| Cognitive | 0.715 | 0.050 | 14.216 | <0.001 |
| Core Depressive | 0.954 | 0.009 | 109.855 | <0.001 |
| Somatic | 0.820 | 0.026 | 31.745 | <0.001 |

Discriminant validity was evaluated using the HTMT method, and results indicated that HTMT values were below 0.90, ranging from 0.532- 0.869. Therefore, the variables exhibit significant discriminant validity.

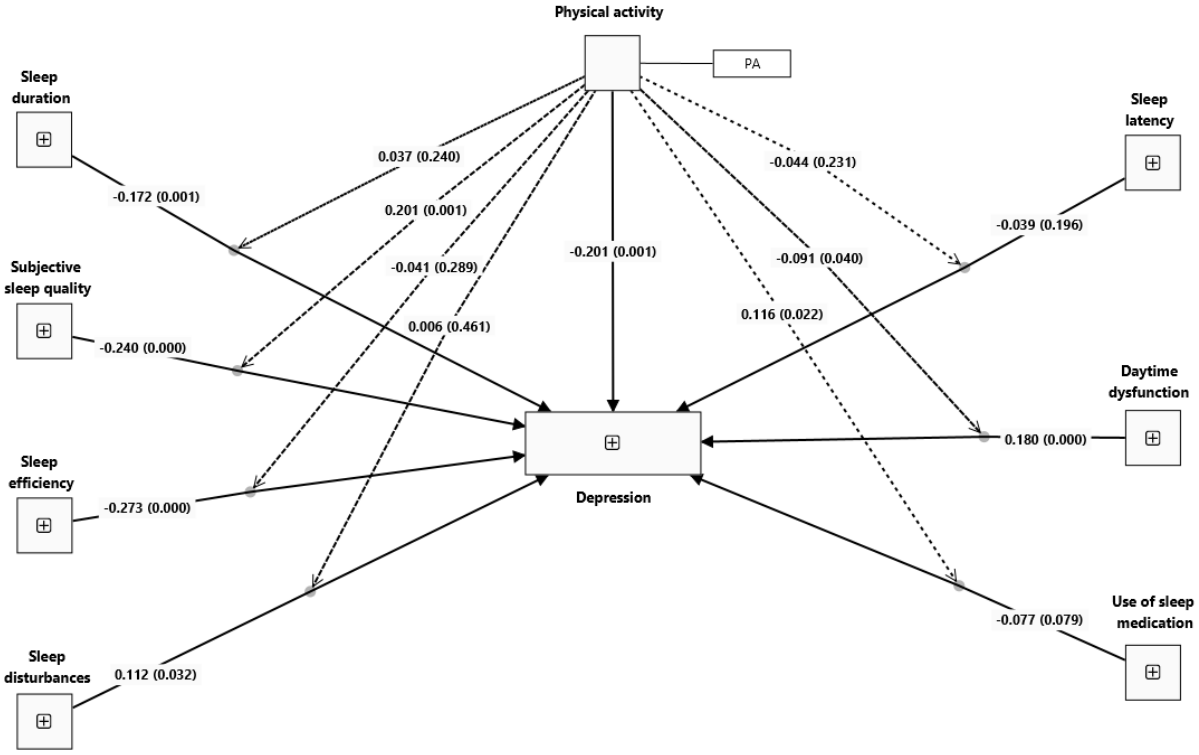


**Figure 3.** Structural model using bootstrapping method

## Path model

In order to test the main research hypotheses, the path model was tested using the bootstrap approach with 5000 samples. The collinearity assumption indicates that there were no multicollinearity issues among predictors, and the highest VIF value was 2.164 (below 2.5). The results of the path model using Bootstrap (Table 6) showed that there was a negative and significant relationship between physical activity and depression ($\beta$ = -0.201, P = 0.001, $f^2$ = 0.073), indicating that a higher level of physical activity is related to lower levels of depression.

Out of seven components of the Pittsburgh SQ Index, it was found that four components had a significant relationship with depression. Depression is significantly negatively correlated with subjective SQ ($\beta$ = -0.240, P < 0.001, $f^2$ = 0.144). Likewise, sleep duration also was negatively correlated with depression ($\beta$ = -0.172, P = 0.001, f = 0.064). The findings show that there was a significant negative association between depression and sleep efficiency ($\beta$ = -0.273, P < 0.001, $f^2$ = 0.055), while depression was positively correlated with sleep

disturbances (β = 0.112, P =0.032 0.019, $f^2$ = 0.026) and Daytime dysfunction (β = 0.180, P< 0.001, $f^2$ = 0.087). The analysis also indicated no significant relationships between (psychiatry symbols) use of sleep medicine, GEE estimates: beta =-0.039, p=0.196; $f^2$ =0.004, or sleep-onset time during polysomnography. Unlike what one might expect given such findings from other studies related to depression, there existed no correlation between them: GEE estimates: beta =-0.077, p=0.079; $f^2$ =0.015. The adjusted R2 value for depression was 0.649 when depression was taken as the dependent variable: this implies that 64.9% of variations in depressive symptoms could be explained through this model (Figure 3).

**Table 6** Path model assessment using bootstrap.

| | β | SE | T value | P values | f |
|---|---|---|---|---|---|
| Physical activity -> Depression | -0.201 | 0.067 | 3.015* | 0.001 | 0.073 |
| Subjective_ sleep quality (SQ) -> Depression | -0.240 | 0.067 | 3.565* | <0.001 | 0.144 |
| Sleep _duration -> Depression | -0.172 | 0.054 | 3.156* | 0.001 | 0.064 |
| Sleep _efficiency -> Depression | -0.273 | 0.072 | 3.776* | <0.001 | 0.11 |
| Sleep _disturbances -> Depression | 0.112 | 0.061 | 1.848* | 0.032 | 0.026 |
| Daytime _dysfunction -> Depression | 0.180 | 0.054 | 3.342* | <0.001 | 0.087 |
| Sleep _latency -> Depression | -0.039 | 0.045 | 0.857 | 0.196 | 0.004 |
| Use of sleep_ medication -> Depression | -0.077 | 0.054 | 1.412 | 0.079 | 0.015 |

## Moderation effect of physical activity

A macro process under Smart-PLS was applied to assess physical activity's moderating effect on the relationship between depression and SQ components. Results of bootstrapping based on 5000 samples are presented in Table 7. According to these results, it was found that PA moderated the relationship between subjective SQ (β = 0.201, P =0.001), daytime dysfunction (β = -0.091, P =0.040), and It had no significant moderating effect on the relationship between other components and depression when used in combination with sleep medication (β = 0.116, P =0.022).

**Table 7** Moderating effect of PA using bootstrap.

| Moderating effect | β | SE | T value | P values |
|---|---|---|---|---|
| PA x Sleep _latency -> Depression | -0.044 | 0.059 | 0.735 | 0.231 |
| PA x Daytime _dysfunction -> Depression | -0.091 | 0.052 | 1.755 | 0.04 |
| PA x Subjective_ sleep quality (SQ) -> Depression | 0.201 | 0.067 | 2.975 | 0.001 |
| PA x Sleep _duration -> Depression | 0.037 | 0.052 | 0.706 | 0.24 |
| PA x Sleep _efficiency -> Depression | -0.041 | 0.073 | 0.557 | 0.289 |
| PA x Use of sleep_ medication -> Depression | 0.116 | 0.058 | 2.016 | 0.022 |
| PA x Sleep _disturbances -> Depression | 0.006 | 0.059 | 0.097 | 0.461 |

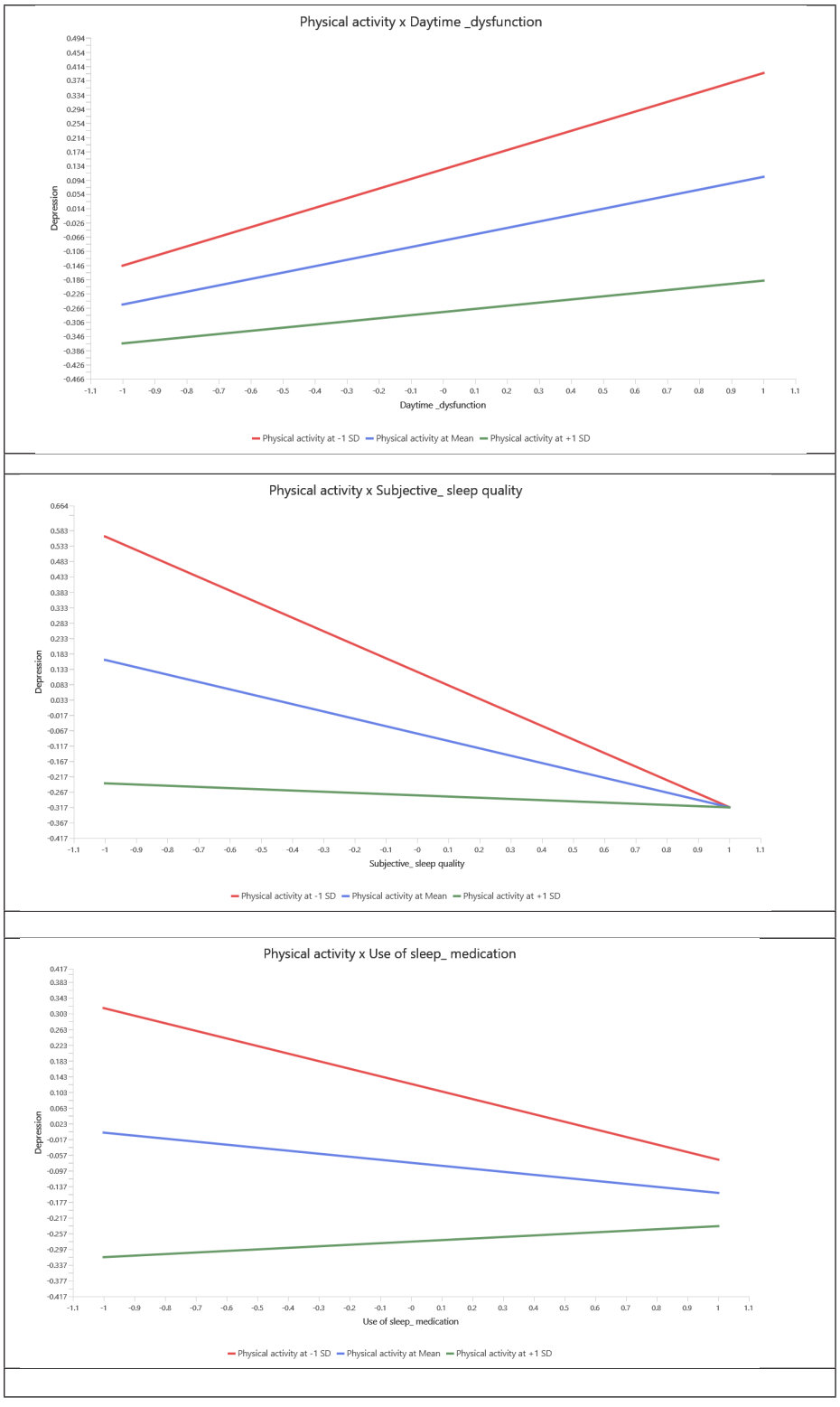


**Figure 4** Slope analysis for moderation effect of PA on the relationship between daytime dysfunction, subjective SQ, and use of sleep medication with depression

## DISCUSSION

The findings of this study showed that, in this sample, there was a negative association between the SQ experienced by the participants and depression. This means that poor subjective SQ was connected to severe depression. Findings that poor subjective SQ is related to greater severity of depressive symptoms in the present study are similar to those of previous studies (Huang et al., 2016; Gerri et al. L, 2024). Additionally, subjective insomnia is associated with depressive symptoms across various psychiatric disorders, indicating a trans-diagnostic feature across different conditions (Nakajima et al., 2023). Likewise, sleep duration is also negatively correlated with depression. The findings showed that more time sleeping is related to a lower occurrence of depression symptoms, hence hinting that duration and quality of sleep may be linked to mental well-being among undergraduates. The results from earlier research that were found to support short sleeping periods in recovering depression cases in colleges also support the present findings (Li et al., 2020; Zhang et al., 2023). Similarly, sleep efficiency (SE) is also negatively correlated with depression. This suggested that SE is associated with lower levels of depression. Moreover, previous studies have also revealed that concurrent SE is a significant predictor of depression intensity, similar to what we have discovered that substantial fluctuation in SE daily causes higher anxiety and depression signs in young people (Yan et al., 2022; Lim et al., 2022). This finding underscores the need to maintain good levels of SQ to avoid depression symptoms. A study has shown that depression is correlated positively with sleep disturbances. The outcomes of this study concur with the findings of the study conducted on 416 Iraqi adults, indicating that there is a positive connection between depressive symptoms experienced during the daytime or in response to these conditions themselves (M Salih et al., 2023). In addition, (Barsha & Hossain, 2020) have illustrated that the increased probability of depression among young women is associated with sleep disorders. Moreover, research indicates that women are more prone to mental health issues like depression (Salk et al., 2017). As a group, these results indicate that many things, from our body nature, chemicals in our system, to the societal environment we are in, might as well play a role in women experiencing lack of sleep or depression. In the present investigation, daytime dysfunction (DD) was positively correlated with depression. This finding is consistent with the prior research, which reported that students with depression exhibited higher levels of DD, which increased over the semester, indicating a direct relationship between the two (Shim et al., 2019). This may be due to the demands of college life, including exams, assignments, and social activities, which can create a cycle of stress and poor sleep. Students struggling to meet these demands may experience both increased daytime dysfunction and worsening depression as the semester progresses. These results also showed that there was no significant relationship between sleep latency and the use of sleep medication for depression.

The findings of this study reveal that physical activity (PA) plays a moderating role in the relationship between SQ and depression among male college students. According to these results, it was found that PA moderated the relationship between subjective SQ, daytime dysfunction, and the use of sleep medication. Particularly, the results indicate that increased PA is associated with enhancements in subjective SQ, reductions in daytime dysfunction, and reduced reliance on sleep medication. These improvements in SQ, in turn, are linked to decreased depressive symptoms. There is evidence from Indonesia (Djajadisastra & Batterham, 2024) that the correlation between SQ and depression is profoundly moderated by physical activity. By examining how

physical activity influences these specific aspects of SQ, specifically subjective SQ, daytime dysfunction, and the use of sleep medication, the study emphasizes the possibility of PA to reduce the harmful effects of poor sleep on mental health. The interaction between PA and SQ indicates that participating in regular physical activity not only improves sleep but also helps relieve depressive symptoms, thus serving as a valuable intervention for improving overall mental well-being. Therefore, the current study found that there was no significant moderating effect of PA on the relationship between other components of SQ and depression. Overall, the present study highlights the significance of integrating physical activity into everyday routines as a strategy to enhance SQ and, in turn, mitigate the likelihood of depression.

This research has been very significant in elucidating the moderating influence of PA on the relationship between SQ and depression in male students in college. The investigation has introduced a new explorative model. Earlier research has focused on these factors individually, but this paper studies the unique problems facing male college students in Iraq, a subject that has not been widely studied. Therefore, fills this gap in the available literature by generating fresh longitudinal information and evolving a model on PA moderating SQ-depression linkage among this group of people. The study's limitation is if the sample size of 139 participants was small such that it could not be used to make general predictions about this particular study. Thus, in order to strengthen this finding or make it universal, we will need an increase in sample size, and then the results will be more conclusive compared to stopping further discussions after this point. However, one thing is missing in this research work because nothing was said concerning the kind of bodily exercises involved. Measuring causation may be complex as it requires long-term follow-up or accounts for confounding variables when investigating how excises affect these associations among others whose levels would result in the highest value on mental health.

The outcomes of this research have a significant indication for each educational context of public wellness strategies. Explain the correlation between BC, sleep quality, PA, and depression among male college students. The study highlights the requirement for an integrated health approach in academic settings. Organizations can utilize these Perspectives to enhance aimed Strategies that develop sleep quality, encourage routine PA, and support mental health. Additionally, the findings can mentor further investigation by determining key aspects for future research, such as the influence of sleep programs on mental wellness results. The decision-makers can also apply these outcomes to support Consolidate Health initiatives that approach the various issues college students face, eventually encouraging improved health and educational excellence.

## CONCLUSION

Additional investigation on the importance of a conceptual model that shows how PA moderates the association between sleep quality and depression is provided by these results. The results of the investigation make clear the exact relationship between physical activity amount and adequacy of sleep among males in college, as well as the level of depression they experienced. There is a direct relationship between the presence of daytime dysfunction or any sleep disturbance during this period and symptoms of depression. Meanwhile,

sleep duration, efficacy and quality of subjective daytime sleepiness had a significant negative correlation with depression. It was found through our research work that the relationship between depression and subjective SQ and daytime dysfunctions is influenced by taking sleeping medication as well as doing PA. However, it exhibits no noticeable effect in moderating the relationship between depressions with the other components of sleep quality. The study results provided mean that some sleep characteristics determine the extent to which physical activity can lower levels of this condition called depression. Although the opportunity to enhance sleep and decrease the requirement for medication, the impact of physical activity on SQ and daytime dysfunction does not always appear to be the same. It suggested that there is a complex interaction linking physical activity levels to SQ as well as mental health statuses among individuals. In different situations, diverse aspects of health behavior should be taken into account, as found in our study. For male college students, depression can be managed by proper SQ and regular PA. These results highlight a need for integrated strategies that aim to improve mental well-being through addressing sleep habits alongside PA. This investigation addresses a gap in the existing literature, improving the field of inquiry.

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