Original Research Article

EFFECT OF EXERCISE ON COGNITIVE FUNCTION, SLEEP PATTERN, STRESS LEVELS, AND METABOLIC ASSESSMENT IN YOUNG ADULTS: A COMPARATIVE STUDY

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ABSTRACT

Background: Young adulthood is associated with major cognitive, psychological, and physiological transitions, often accompanied by irregular sleep, psychosocial stress, and increased cognitive demands. Sedentary lifestyles have become increasingly prevalent due to technological advancement and competitive environments, thereby adversely affecting mental and physical health. Regular exercise is recognised as an effective lifestyle intervention that improves overall well-being. Although its cardiovascular and metabolic benefits are well established, limited studies have explored its effects on higher mental functions, particularly in Asian populations. This study aimed to evaluate the influence of regular exercise on cognitive, psychological, and metabolic health in young adults.
Materials and Methods: A cross-sectional comparative study was conducted among 100 healthy young adult males aged 20–30 years at Mysore Medical College and Research Institute. Participants were divided equally into exercising and sedentary groups. Cognitive function was assessed using the Kokmen Short Test of Mental Status, sleep quality using the Pittsburgh Sleep Quality Index, and stress using the Perceived Stress Scale. Waist circumference, blood pressure, blood sugar, renal function tests, and lipid profile were evaluated.
Results: The exercise group demonstrated significantly higher cognitive scores (35.64 ± 1.73 vs 33.41 ± 3.01, p<0.001) and better sleep quality with lower PSQI scores (3.21 ± 1.02 vs 6.61 ± 1.97, p<0.001). Moderate stress levels were significantly lower in exercisers (p=0.032). Waist circumference and blood pressure were significantly lower in the exercise group (p<0.05). Serum creatinine and uric acid levels were also significantly lower (p<0.05), while other laboratory parameters showed no significant association.
Conclusion: Regular exercise improves sleep quality, reduces stress, and enhances cognitive and metabolic health, thereby promoting holistic mental and physical well-being in young adults.
Keywords: Exercise, Cognitive function, Sleep quality, Stress, Metabolic health, Young adults, Physical activity, PSQI, Perceived stress scale.

INTRODUCTION

Young adulthood represents a critical developmental period characterised by heightened cognitive demands, academic pressures, and significant lifestyle transitions that collectively impact mental and physical health.[1]During this phase, individuals face multiple challenges, including irregular sleep patterns, increased psychosocial stress, sedentary behaviour, and emerging metabolic risk factors that can have long-term health consequences.[2,3] The modern lifestyle,predominantly sedentary, contributes to reduced attention, increased fatigue, and compromised overall well-being.[4]

Cognitive function, sleep quality, stress levels, and metabolic health are interconnected domains that significantly influence overall health and academic and professional performance in young adults.[5] Current evidence indicates that enhanced cardiorespiratory fitness is linked to improved cognitive performance, favourable brain health indices, and structural brain adaptations, highlighting physical fitness as an important modifiable factor influencing mental and metabolic health..[5,6] Furthermore, sleep quality mediates the relationship between stress and emotional well-being, emphasizing the interdependence of these health domains.[7] Regular physical exercise has emerged as a promising intervention to address these complex challenges. A significant number of studies demonstrate that exercise exerts beneficial effects across multiple health domains through various physiological and psychological mechanisms.[8]

Despite the growing evidence supporting exercise benefits across individual health domains, there remains a significant gap in the literature regarding comprehensive, simultaneous assessments of cognitive function, sleep quality, stress levels, and metabolic health in young adults.[10] Most existing studies focus on one or two domains, and few employ well-controlled comparative designs that examine exercising versus sedentary individuals across all these parameters concurrently.[9] Only a few studies have explained its influence on these parameters, particularly in Asian populations.

In the context of the rising prevalence of sedentary lifestyles and the growing burden of cognitive, psychological, and metabolic challenges among young adults, there is a need for integrative research evaluating the multidimensional benefits of regular physical activity. The present study addresses this gap by undertaking a comprehensive comparative assessment of cognitive performance, sleep quality, perceived stress, and metabolic parameters in exercising versus sedentary young adult males. By examining these domains collectively, the study provides consolidated evidence supporting regular exercise as a holistic and effective health-promotion strategy during early adulthood.

MATERIALS AND METHODS

Study Design and Setting

This was a cross-sectional comparative study conducted at Mysore Medical College and Research Institute, Mysore, Karnataka, India. The study was designed to compare multiple health parameters between young adults who engage in regular exercise and those who didn't take part in any structured physical activity. The study was conducted after approval from the Institutional Ethics Committee.

Study Population and Sample Size

The study population comprised young adult males aged 20 to 30 years recruited from the general population in Mysore. A total of 100 participants were enrolled in the study and were divided into two groups.

Participants: Participants were classified into two groups based on their self-reported physical activity patterns:

Study Group (n=50): Participants who had been engaging in regular structured exercise for a minimum period of 6 months before enrollment. Regular exercise was defined as planned, structured physical activity (aerobic and resistance) performed at least 3-4 times per week, with sessions lasting 40 to 60 minutes.

Sedentary Group (n=50): Participants who were not practising any structured physical activity.

Inclusion Criteria

- Male
- Age between 20 and 30 years
- Literates - able to understand and complete questionnaires in the local language or English.

Exclusion Criteria

- Chronic illness.
- Sleep and Mood Disorders.
- Addictive Behaviours.
- Long-term use of any medications.

Data Collection Procedures

All participants were informed about the study. After providing the written informed consent, participants underwent a comprehensive assessment protocol that included questionnaire administration, anthropometric measurements, blood pressure assessment, and blood sample collection. All assessments were conducted following standardised protocols to ensure consistency and reliability.

Anthropometric Measurements

Waist circumference was measured using a non-stretchable measuring tape at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest, with the participant standing upright and measured at the end of a normal, relaxed expiration.[10]

Blood Pressure Measurement

Blood pressure was measured using an automated sphygmomanometer following standardized protocols. Participants rested in a seated position for at least 5 minutes before the procedure. The blood pressure cuff was placed on the participant's upper arm at heart level. A total of 3 consecutive readings were taken from the same arm, with a 2-minute rest interval between each measurement, and the average of three readings was recorded. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were documented in millimetres of mercury (mmHg).[11]

Cognitive Function Assessment

Cognitive function was assessed using the Kokmen Short Mental Status Examination (SMSE), a validated and widely used screening tool for evaluating global cognitive function. The SMSE assesses multiple cognitive domains, including orientation, attention, memory, calculation, language, and visuospatial skills. The examination consisted of several tasks that yielded a total score ranging from 0 to 38, with higher scores indicating better cognitive performance. The SMSE was administered in a quiet, distraction-free environment, and scoring was performed according to standardized criteria.[12]

Sleep Quality Assessment

Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), a self-administered questionnaire that assesses sleep quality and disturbances over the previous one-month period. The PSQI consists of 19 individual items that generate seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, and daytime dysfunction. Each component score ranges from 0 to 3, and the seven component scores are summed to yield a global PSQI score ranging from 0 to 21. A global PSQI score greater than 5 indicates poor sleep quality, while lower scores indicate better sleep quality.[13]

Stress Level Assessment

Perceived stress was measured using the Perceived Stress Scale (PSS), a widely used psychological instrument for assessing the degree to which situations in one's life are appraised as stressful. The PSS is a 10-item questionnaire that measures the frequency of perceived stress-related thoughts and emotions experienced during the past month on a 5-point Likert scale (0 = never to 4 = very often). Total PSS scores range from 0 to 40, with higher scores indicating higher levels of perceived stress. Scores are typically categorised as low stress (0-13), moderate stress (14-26), and high stress (27-40).[14]

Laboratory Investigations

Venous blood samples (approximately 10 mL) were collected from all participants after an overnight fast of at least 8 hours. Blood samples were collected using standard venipuncture techniques and were immediately processed according to laboratory protocols. The following biochemical parameters were analyzed:

Blood Glucose: Fasting blood glucose was measured using the glucose oxidase method.

Renal Function Tests (RFT): Serum creatinine and blood urea were measured using automated enzymatic assays. Serum uric acid was also quantified.

Lipid Profile: Total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) were measured using enzymatic colorimetric methods.

All laboratory analyses were performed at the clinical biochemistry laboratory of Mysore Medical College and Research Institute using quality-controlled procedures and calibrated instruments.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using the appropriate statistical software SPSS version 22. The descriptive data are given as mean ± SD. The independent t-test was used to compare means, and a p-value < 0.05 is considered significant.

RESULTS

A total of 100 young adult males participated in the study, with 50 participants in each group (exercise and sedentary). The mean age of participants was 25.2 ± 2.8 years in the exercise group and 24.9 ± 2.9 years in the sedentary group, with no significant difference between groups (p=0.58).

Table 1: Waist circumference in exercising and sedentary groups

Parameter	Exercising Group (Mean ± SD)	Sedentary Group (Mean ± SD)	p-value
Waist Circumference (cm)	33.14 ± 4.27	36.61 ± 5.62	0.01

Table 1 showing the mean waist circumference (cm) with standard deviation in exercising and sedentary young adult males. The sedentary group demonstrated a significantly higher waist circumference (36.61 ± 5.62 cm) compared to the exercising group (33.14 ± 4.27 cm) (p = 0.01), indicating greater central adiposity among sedentary individuals.

Table 2: Mean Blood pressure in exercising and sedentary groups

VARIABLES	EXERCISING GROUP (Mean ± SD)	SEDENTARY GROUP (Mean ± SD)	P VALUE
SBP (mmHg)	118.21 ± 8.42	123.67 ± 9.65	0.01*
DBP (mmHg)	74.62 ± 6.03	78.31 ± 6.85	0.02*

Table 2 shows the mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) among exercising and sedentary young adult males. Both SBP and DBP were higher in the sedentary group compared to the exercising group, suggesting a tendency toward elevated blood pressure among sedentary individuals relative to those engaged in regular physical activity.

Table 3: Cognition Scores

Variable	Sedentary Group (Mean ± SD)	Exercise Group (Mean ± SD)	p-value
Cognition Score	33.41 ± 3.01	35.64 ± 1.73	<0.001

Table 3 shows the comparison of cognition scores between the two groups; the exercising group hadsignificantly higher cognition scores.

Table 4: Sleep Quality Components Comparison

Sleep Quality Parameter	Sedentary Group (Mean ± SD)	Exercise Group (Mean ± SD)	p-value
Subjective Sleep Quality	1.10 ± 0.35	0.52 ± 0.32	<0.001
Sleep Latency	1.40 ± 1.07	1.30 ± 0.95	0.622
Sleep Duration	1.07 ± 0.51	0.42 ± 0.13	<0.001
Habitual Sleep Efficiency	1.03 ± 0.48	0.09 ± 0.10	<0.001
Sleep Disturbances	1.10 ± 0.57	1.20 ± 0.79	0.47
Daytime Dysfunction	0.60 ± 0.12	0.41 ± 0.09	<0.001
TOTAL SCORE	6.61 ± 1.97	3.21 ± 1.02	<0.001

Table 4 shows Subjective sleep quality, sleep efficiency, sleep duration, and daytime sleep dysfunction scores were significantly lower in the exercise group, suggesting better sleep quality components in the exercise group.

Table 5: Distribution of perceived stress levels in exercising and sedentary groups

Stress Level	Exercise Group (%)	Sedentary Group (%)
Low stress	24	6
Moderate stress	74	92
High stress	2	2

Table 5 showing the percentage distribution of low, moderate, and high perceived stress among exercising and sedentary young adult males. A greater proportion of the exercising group reported low stress (24%) compared to the sedentary group (6%). Conversely, moderate stress was more prevalent in the sedentary group (92%) than in the exercising group (74%). The prevalence of high stress was low and comparable in both groups (2%), indicating overall higher perceived stress among sedentary individuals.

Table 6: Comparison of glycemic, renal and lipid profile parameters between exercising and sedentary groups

VARIABLES	EXERCISING GROUP (Mean ± SD)	SEDENTARY GROUP (Mean ± SD)	P VALUE
Blood glucose (mg/dL)	96.18 ± 19.42	102.92 ± 21.42	0.08
HbA1c (%)	5.03 ± 0.358	5.18 ± 0.28	1.00
Urea (mg/dL)	19.74 ± 4.01	19.98 ± 3.60	0.88
Creatinine (mg/dL)	0.70 ± 0.09	0.78 ± 0.11	0.001*
Serum uric acid (mg/dL)	3.92 ± 0.71	4.57 ± 0.98	<0.001*
Total cholesterol (mg/dL)	144.12 ± 31.66	151.69 ± 34.09	0.16
Triglyceride (mg/dL)	94.23 ± 26.91	97.17 ± 28.48	0.58
HDL (mg/dL)	44.72 ± 6.89	40.81 ± 6.71	**0.02***
LDL (mg/dL)	86.41 ± 25.94	92.00 ± 27.36	0.30
VLDL (mg/dL)	18.84 ± 5.38	19.11 ± 5.77	0.56

Table 6 shows The exercising group demonstrated significantly lower serum creatinine levels (0.70 ± 0.09 mg/dL vs 0.78 ± 0.11 mg/dL, p=0.001) and serum uric acid levels (3.92 ± 0.71 mg/dL vs 4.57 ± 0.98 mg/dL, p<0.001) compared to the sedentary group. HDL cholesterol levels were significantly higher in the exercising group than in the sedentary group (44.72 ± 6.89 vs 40.81 ± 6.71 mg/dL, p=0.02).

DISCUSSION

The present cross-sectional comparative study provides strong evidence that regular exercise is associated with superior cognitive function, better sleep quality, lower stress levels, and improved metabolic health indicators in young adult males.

Our study demonstrated that participants in the exercise group exhibited significantly higher cognitive function. This finding aligns with the emerging evidence supporting the cognitive benefits of physical activity in young adults. A 2024 meta-analysis by Poon et al. reported that high-intensity interval training (HIIT) interventions were associated with significant improvements in cognitive function markers among adults participating in regular physical activity.[15] The cognitive enhancement associated with regular exercise is possibly due to neurogenesis and increased blood flow to the brain.

Our study demonstrated that the exercise group had significantly better sleep quality compared to the sedentary group. Component-wise analysis revealed that the exercise group demonstrated significant improvements in subjective sleep quality, sleep duration, habitual sleep efficiency, and daytime dysfunction. Although, sleep latency and sleep disturbances did not vary significantly between groups, exercise appeared to primarily enhance sleep consolidation and overall sleep efficiency rather than sleep initiation. Our findings are strongly supported by a study conducted in 2020 by Kaur et al. investigating physical activity effects on sleep quality in middle-aged adults, which reported similar improvements in PSQI scores among physically active participants compared to sedentary controls.[16]

The study found that regular physical activity was associated with better subjective sleep quality and reduced daytime dysfunction, consistent with our observations. The beneficial effects of exercise on sleep quality are mediated through decreased sympathetic activity and enhanced parasympathetic activity, strengthening the circadian rhythm alignment; increasing adenosine accumulation leading to greater sleep pressure; and promoting thermoregulatory adaptation that supports sleep initiation and maintenance.[16]

The exercise group demonstrated a higher proportion of individuals with low stress levels, while the sedentary group showed a predominance of moderate stress. High stress levels were minimal and comparable in both groups. Kaur et al. (2020) reported that physically active middle-aged adults exhibited significantly lower perceived stress levels compared to sedentary peers, with regular exercise serving as a protective factor against stress accumulation.[17]This supports literature indicating regular exercise is known to reduce levels of perceived stress and improve stress resilience, possibly through modulation of the hypothalamic–pituitary–adrenal (HPA) axis and enhanced release of endorphins.[18]

The sedentary group exhibited a significantly higher waist circumference compared to the exercising group, reflecting a 10.5% increase in central adiposity among sedentary individuals. Similarly, Serrablo-Torrejón et al. (2020), in a meta-analysis of high-intensity interval training (HIIT) interventions, reported significant reductions in waist circumference following structured exercise programs.[19]These findings reinforce the concept that regular physical activity facilitates the reduction of visceral adiposity by enhancing energy expenditure and fat oxidation, thereby contributing to decreased waist circumference.[19]

Lee et al. (2022) investigated the effects of regular exercise on cardiovascular function and reported significant reductions in both systolic and diastolic blood pressure following structured exercise interventions.[20]In agreement with these findings, both systolic and diastolic blood pressure were higher in the sedentary group than in the exercising group, indicating a greater predisposition to elevated blood pressure among sedentary individuals. The blood pressure–lowering effect of regular exercise is largely mediated through improvement in endothelial function and increased nitric oxide bioavailability, which promote vasodilation and reduce peripheral vascular resistance.[19,21,22]

Lower serum creatinine levels were observed in the exercising group, suggesting improved renal filtration capacity and overall renal function. Previous studies have demonstrated that regular physical activity enhances renal hemodynamics, reduces oxidative stress within renal tissues, and improves glomerular filtration efficiency, thereby contributing to better renal functional status.[23]

Lower serum uric acid levels were observed in the exercising group compared to the sedentary group. Uric acid, the final product of purine metabolism, reflects the alterations in cellular energy turnover. During physical activity, skeletal muscles utilize purine nucleotides for ATP regeneration, which facilitates improved uric acid clearance and contributes to reduced circulating levels. The comparatively lower uric acid levels among exercisers indicate enhanced metabolic efficiency and optimized muscular energy utilization.[24]

Chaudhary (2024) examined the influence of physical activity on blood lipid profiles and reported that regular exercise significantly increased HDL cholesterol levels while improving the overall lipid profile.[25]The study demonstrated that individuals engaging in moderate-to-vigorous physical activity for at least 150 minutes per week exhibited an 8–12% increase in HDL levels compared to sedentary controls. In alignment with these observations, HDL cholesterol levels were significantly higher in the exercising group compared to the sedentary group, reflecting a 9.6% increase among physically active individuals. This finding is clinically important because higher HDL cholesterol levels are associated with a lower risk of cardiovascular disease, and even small elevations in HDL may confer protective cardiovascular effects.[26]

No significant differences were observed between the groups with respect to fasting blood glucose, total cholesterol, triglycerides, or LDL cholesterol. This lack of statistical significance may be attributable to several factors. The participants in both groups were young, apparently healthy adults who had not yet developed overt metabolic disturbances. Additionally, genetic predisposition, dietary habits, and other lifestyle variables may independently influence glycemic and lipid parameters, potentially decreasing the observable effects of exercise status alone.

CONCLUSION

Our study concluded that regular exercise is strongly associated with multiple dimensions of health and well-being in young adult males. Our findings reveal that young adults who engage in regular exercise for at least six months exhibit significantly superior cognitive function, markedly better sleep quality, lower perceived stress levels, and improved metabolic health indicators compared to their sedentary peers. Since early adulthood is a key period for primordial and primary prevention, promoting regular exercise in young adults may have long-term benefits for mental and physical health.

Future Research Directions

Conduct longitudinal randomised controlled trials

Incorporate dietary assessment.

Examine dose-response relationships (frequency, intensity, duration of exercise).

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