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Blood sugar level changes on cognitive function among students undertaking part-time employment

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Abstract

Background: Part-time work among students has become a common phenomenon in higher education, often driven by financial constraints, daily needs, and the desire for independence. However, the integration of work and study can pose significant challenges, particularly concerning the heavy workload of assignments and potential health risks. Cognitive functions, which include attention, memory, language, and visuospatial skills, can be affected by various factors, including health disorders such as hyperglycemia. Hyperglycemia, or high blood glucose levels, is often associated with a decline in cognitive function. In Indonesia, the prevalence of hyperglycemia is increasing, with the highest undiagnosed rates in the age group 17-29 years.
Purpose: To analyze the relationship between blood glucose levels and cognitive function among students undertaking part-time employment.
Method: Applying an observational analytical approach with a cross-sectional design. The sample comprised 100 part-time students from the Management Study Program at the Faculty of Economics, Prima Indonesia University. Data collection was carried out using observation sheets, and the Spearman Rank Correlation test was applied for analysis.
Results: Most respondents were 18 years old (45%), with males comprising 55% of the sample. A majority (53%) had been working part-time for less than three months, while 47% had worked for over three months. Blood glucose levels, assessed using a glucometer, ranged from 66 to 217, with a median of 96. Cognitive function, evaluated through the Digit Symbol Substitution Test (DSST), showed scores ranging from 17 to 53, with a median of 38.
Conclusion: There is a significant relationship between cognitive function and blood glucose levels among part-time working students.

Keywords: Blood Glucose Levels; Cognitive Function; Digit Symbol Substitution Test; Part-Time Work; Students.

INTRODUCTION

Part-time work, which involves various types of jobs outside of academic schedules and activities, has now become an integral component of the student experience in higher education (Arif, Rosni, Nurman, Soedirman, & Cimita, 2023). Limited financial support from parents, difficulties in funding education and daily needs, as well as the desire for independence and filling spare time outside of classes, are often key factors driving students to work while studying (Alvionita, Windrayadi, & Purwanto 2022). Balancing work and academics presents significant challenges for students, with academic workloads often imposing constraints, leading to stress and potential health risks for those involved (Sakdiyeh, Ruski, & Widjaya, 2023).

Cognitive function refers to the brain's ability to

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encompass important aspects such as attention, registration, memory, calculation, recall, language, judgment, writing, reading, and visuospatial abilities. Impairment in cognitive function indicates dysfunction or a decline in brain capability, involving changes in affect, language skills, cognition, behavior, or personality. Factors such as anoxia, endocrine issues, structural abnormalities, trauma, or vascular conditions can affect brain function and lead to these changes (Apriliandri, Citrawati, & Ariadno, 2021). Conditions such as elevated blood sugar levels, or hyperglycemia, can exacerbate cognitive decline and increase the risk of cognitive impairment diseases (Okaniawan, & Agustini, 2021).

Blood glucose levels refer to the concentration of glucose in the bloodstream. Glucose, a type of monosaccharide carbohydrate, is crucial as the body's main energy source (Fahmi, Firdaus, & Putri, 2020). Blood glucose levels higher than 100 mg/dL when fasting or 126 mg/dL during random testing can be defined as hyperglycemia (Hammer, Storey, Soltow Hershey, Brady, Davis, Mandolfo, & Olausson, 2019). The prevalence of hyperglycemia in adults reaches 56.8%, with 38.8% experiencing prediabetes and 18.0% having undiagnosed diabetes mellitus (DM). There is a significant difference in glycemic status across age groups, with the highest prevalence of undiagnosed DM occurring in the 17-29 age group. Epidemiological studies report a rise in blood glucose issues in Indonesia, affecting 13% of the diagnosed population and continuing to increase annually (Bohari, Nuryani, Abdullah, Amaliah, & Hafid, 2021).

This study seeks to examine the effects of part-time employment on students in the Faculty of Economics at of Prima Indonesia University, with a focus on the possible link between hyperglycemia and cognitive decline. It emphasizes the role of blood sugar levels, particularly hyperglycemia, as a potential contributor to cognitive impairment. By gaining insights into this connection, the research aims to offer valuable support for improving the well-being of part-time working students.

RESEARCH METHOD

This observational analytic study with a cross-sectional approach was conducted from March to April 2024. The population includes part-time working students from the Faculty of Economics at Prima Indonesia University. Sampling was carried out using cluster random sampling.

The two main variables in this study are cognitive function and blood glucose levels. Data collection tools included the Digit Symbol Substitution Test (DSST) questionnaire and a glucometer for measuring blood glucose. The DSST consists of five rows with a total of 125 empty boxes, each linked to random numbers from 1 to 9. Symbols appear above these rows, which respondents must match with the corresponding numbers. Respondents are instructed to fill in the boxes with the correct symbols as quickly as possible within 1.5 to 2 minutes, with the total number of correct responses serving as the score.

The Spearman's rho test was used to analyze correlations, with correlation strength categorized as follows: 0 to ±0.199: Very Weak; ±0.20 to ±0.399: Weak; ±0.40 to ±0.599: Moderate; ±0.60 to ±0.799: Strong; ±0.80 to ±1.000: Very Strong.

Inclusion criteria include evening class students who work part-time, while exclusion criteria are students not in evening classes or without part-time jobs. Data were statistically analyzed using SPSS, with the Spearman test applied to determine the correlation between the two variables. This study received ethical approval from the research ethics committee with approval number 184/KEPK-FIK/I/2024.

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RESEARCH RESULTS

Table 1. Characteristics of the Respondents (N=100)

Variable	Result
Age (Mean±SD)(Range)(Year)	**(18.58±0.934)(17-23)**
Age (n/%)	
17	7/7.0
18	45/45.0
19	35/35.0
20	11/11.0
21	1/1.0
23	1/1.0
Gender (n/%)	
Male	55/55.0
Female	45/45.0
Part-time Working Period (n/%)	
≤ 3 Month	53/53.0
> 3 month	47/47.0

Table 1. Characteristics of respondents show an average age of 18.58 years with a standard deviation of 0.934 and an age range of 17-23 years. The majority of respondents were 18 years old, totaling 45 individuals (45.0%). Most respondents were male, accounting for 55 individuals (55.0%). The majority had part-time work experience of three months, totaling 53 respondents (53.0%).

Table 2. Cognitive Function and Blood Glucose Levels

Variable	Result			
	SD	Median	Mean	Range
Cognitive function	6.4	38	36.5	17 - 53
Blood glucose level	36.1	96	105.8	66 - 217

*Measuring instrument: *DSST, **Glucometer*

Table 2 presents cognitive function assessed using the DSST, with a standard deviation of 6.4, a median score of 38, and an average score of 36.5, spanning a range of 17 to 53. In contrast, blood glucose levels measured with a glucometer showed a standard deviation of 36.1, an average of 105.8, and a median of 96, within a range of 66 to 217.

Table 3. Spearman Rank Correlation Analysis between Cognitive Function and Blood Glucose Levels

Variable	Cognitive Function	
	P Value	r
Blood Sugar Level	0.002	-0.307

Table 3. The relationship between cognitive function and blood glucose levels, analyzed using the Spearman test, shows a p-value of 0.002 and a correlation coefficient of -0.307.

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DISSCUSSION

The study reveals a significant association between cognitive function and blood glucose levels in part-time working students. This finding was validated through the Spearman rho test, which produced a p-value of 0.002 and a correlation coefficient of -0.307. The moderate negative correlation suggests that as blood glucose levels increase, cognitive function tends to decrease.

These findings are consistent with a study that reported a significant relationship between blood glucose levels and cognitive function, indicated by a p-value < 0.05 (Nanda & Purwanti, 2023). In a separate study involving respondents aged 46 to 81 years, including some non-diabetic individuals, fasting glucose tests were used to measure blood sugar levels, while cognitive function was evaluated using the Cognitive Ability Screening Instrument (CASI). The study also found a significant relationship between blood glucose levels and cognitive function (Cai, Wang, Feng, & Ni, 2020). However, another study found no significant relationship, with a p-value > 0.05. This discrepancy may be due to differences in cognitive assessment tools: the previous study used the Mini Mental State Examination (MMSE), while the current study utilized the Digit Symbol Substitution Test (DSST) (Margaretha, Turana, Barus, & Widjaja, 2020).

Subjects with elevated blood glucose levels have significantly lower cognitive abilities, including orientation, concentration, attention, verbal memory, and visuospatial skills. Hyperglycemia impairs attention and verbal abilities. This correlation is attributed to increased oxidative stress associated with hyperglycemia and the effects of working while studying, as well as the accumulation of Advanced Glycation End-products (AGEs) which can cause prolonged complications in the vascular and neurovascular systems, leading to decreased cognitive function (Printzlau, Myers, Manohar, & Stokes, 2022; Cai et al., 2020).

The study also considered the effects of hypoglycemia or below-normal blood glucose levels on cognitive function. Insufficient glucose supply to the brain can cause severe cognitive impairments associated with structural changes in the brain. Prolonged uncontrolled hypoglycemia has been linked to reductions in gray matter and white matter volumes in the temporal, parietal, and occipital cortices, leading to diminished cognitive abilities (Nevo-Shenker & Shalitin, 2021). However, the number of respondents experiencing hypoglycemia in this study was insufficient for adequate statistical analysis. This limitation prevents a definitive conclusion about the relationship between hypoglycemia and cognitive function among part-time working students.

Hyperglycemia, or elevated blood glucose levels, can cause nerve damage in the brain and increase the risk of cognitive decline. Structural abnormalities in the brain, such as reduced total and regional gray matter and white matter volumes, are closely linked to increased glucose levels, particularly in the hippocampus, a key area involved in attention and memory (Chen, Pan, Kang, Lu, Tan, Liang, & Qiu, 2021). This correlation is significant for part-time working students who face daily challenges. Irregular eating patterns, poor diet, lack of physical activity, and stress—often termed oxidative stress—associated with juggling work and study, can contribute to uncontrolled blood glucose levels and cognitive impairments, particularly memory dysfunction (Handing, Leng, Kritchevsky, & Craft, 2020; Hanisya, & Kurnia, 2018).

Oxidative stress from hyperglycemia disrupts cognitive function by increasing reactive oxygen species (ROS) and reactive nitrogen species (RNS), and decreasing antioxidants in the brain. Elevated oxidative stress is associated with reduced levels of neurotrophic factors such as nerve growth factor and insulin-like growth factor, leading to nerve malnutrition (Shieh, Huang, & Lin, 2020). Additionally, hyperglycemia increases the production of lipid peroxidation products like 4-hydroxynonenal (HNE), which diminishes antioxidant defense mechanisms and boosts beta-amyloid (Aβ) production, contributing to neurodegeneration. Hyperglycemia also triggers elevated production of advanced glycation end-products, activation of protein kinase C (PKC) isoforms, and hexosamine pathway, all of which enhance oxidative damage and vascular complications, resulting in neuronal dysfunction and nerve injury that ultimately affect cognitive function (Gupta, Pandey, Rumman, Singh, & Mahdi, 2023). This study underscores the importance of maintaining stable blood glucose levels to support optimal cognitive function. Attention

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to better dietary habits, regular physical activity, and stress management is essential for maintaining cognitive health among part-time working students.

CONCLUSION

There is a significant relationship between cognitive function and blood glucose levels among part-time working students. The Spearman correlation test results showed a p-value of 0.002 and a correlation coefficient of -0.307, indicating a moderate correlation where increased blood glucose levels are associated with decreased cognitive function.

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