DETERMINANTS OF BRAIN-DERIVED NEUROTROPHIC FACTOR IN YOUNG ADULTS: A CROSS-SECTIONAL STUDY

Farida Ahmad[1], Zubia Shah[1], Afsheen Mahmood[1], Nighat Ghafoor[1], Tooba Khan[2], Mahvish Javed[1]

ABSTRACT

Background: Brain-Derived Neurotrophic Factor (BDNF) is essential for neuronal survival, plasticity, and cognitive function. Its levels are influenced by factors such as physical activity, diet, sleep, stress, and metabolic health. While extensively studied in older adults, data on BDNF determinants in young adults remain limited. Identifying these factors may aid in promoting early brain health and preventing future cognitive decline**.**

Objectives: To determine the effects of body mass index, waist hip ratio, level of stress, and memory scores on brain-derived neurotrophic factor.

Material and Methods: Forty young adults participated in a cross-sectional study at Khyber Girls Medical College. In addition to collecting demographic information, anthropometric measurements were taken, including waist-hip ratio and body mass index (BMI). We used the Digit Span Test from the Wechsler Adult Intelligence Scale (WAIS-III) to assess cognitive function. We assessed stress levels and anxiety using the Depression, Anxiety, and Stress Scale (DASS). Standard methods were used to measure serum brain-derived neurotrophic factor (BDNF). The data were analyzed using SPSS version 20.

Results: With an R-squared value of 0.532, multivariate regression revealed about 53.2% of the variance in BDNF levels. With F = 9.9 and p = 0.001, the regression model was statistically significant. Stress had a strong negative link with BDNF (B = -58.46, p = 0.001), short term memory showed an insignificantly negative relationship with BDNF (B = -6.96, p = 0.60). Waist hip ratio displayed a significant influence (B = 2664, p = 0.05), while BMI exhibited a non-significant effect (B = -8.61, p = 0.63).

Conclusion: This study highlights the critical role of stress as a significant determinant of BDNF, while the waist-hip ratio also shows a meaningful relationship. The non-significant effects of BMI and memory suggest that additional factors may mediate their influence on neurotrophic levels.

Keywords: Body mass index, Brain-derived neurotrophic factors, stress, memory.

INTRODUCTION

BDNF is a crucial neurotrophin first identified in 1995 (1). Dendrite production and memory enhancement depend critically on this 119-amino acid polypeptide (2). Brain-derived neurotrophic factor (BDNF) is located peripherally and within the brain, comprising the motor cortex, basal ganglia, cerebellum, and spinal cord. The deficiency of BDNF in these areas is associated with neurological illnesses such as ALS, Huntington's disease, Parkinson's disease, and spinocerebellar ataxias (3, 4). It supports neuroplasticity and cognition, with levels affected by age, cold exposure, and high altitude (2, 3). Omega-3 fatty acids, iron, and curcumin enhance BDNF levels **(**4, 5). Caloric restriction and ketogenic diet are implicated in raising its levels (6, 7). Chronic physical activity is linked to lower baseline BDNF levels, while acute exercise leads to a more significant increase in BDNF**.** Studies indicate that physically trained adults have lower serum BDNF levels than sedentary individuals, yet their memory improves due to receptor upregulation. In contrast, acute exercise significantly elevates BDNF levels (8, 9).

[1] Khyber Girls Medical College, Peshawar
[2] Khyber Medical College, Peshawar

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Address for Correspondence
Zubia Shah
Associate Professor of Physiology, Khyber Girls Medical College, Peshawar, Pakistan
zubiashah1971@gmail.com
+92 300 5942110

While previous studies have identified various factors affecting BDNF levels(2, 3) , there remains a need to comprehensively evaluate its relationship with BMI, stress levels, waist-hip ratio, and cognitive function in young adults. This research aims to explore BMI, memory, and stress levels as determinants of BDNF. Data on BDNF determinants in young adults remain limited. Identifying these factors may aid in promoting early brain health and preventing future cognitive decline**.**

METHODS

This cross-sectional research was carried out at Khyber Girls Medical College, Peshawar, over six months following approval from the Advanced Study and Research Board, Khyber Medical University. The sample size was calculated using the WHO sample size calculator, resulting in the selection of 60 volunteers via convenience sampling(10).

The study included adult female volunteers (aged 18–25 years) with a sedentary lifestyle who participated between the 4th and 7th day of their menstrual cycle.Exclusion criteria included a history of psychiatric or neurological disorders, use of antidepressant medications, cardiovascular or respiratory diseases, musculoskeletal disorders, and smoking.after inclusion and exclusion final sample size was 40.

Anthropometric measurements comprised body mass index (BMI), determined by weight (kg) divided by height squared (m^2), and waist-hip ratio. The Digit Span Test evaluated cognitive performance using the Wechsler Adult Intelligence Scale (WAIS-III), whilst stress and anxiety levels were measured using the Depression, Anxiety, and Stress Scale (DASS).
The Human BDNF ELISA Kit (Catalog No: E-EL-H0010 96T, Elabscience®) was used to measure serum BDNF levels. SPSS version 20 was used for data analysis. Shapirowilk test was used for normality. Continuous variables were expressed as mean ± standard deviation . A multiple linear regression analysis was used to examine the relationship between BDNF and the predictor variables, BMI, waist-hip ratio, and memory. A p-value of <0.05 was considered statistically significant.

RESULTS

The average age of participants was 20 ± 2 years, with an average BMI of 22.3 ± 2.3 kg/m^2 and a mean waist-hip ratio of 0.79 ± 0.05. Participants who were part of this study presented in between day 4 and day 7 of their menstrual cycles. The mean digit span test scores were 18.8 ± 3 while the Mean Stress scores were 12 ± 3. The normal BDNF ranges from 70 pg/ml – 1455 pg/ml at baseline. Mean serum BDNF levels were 765± 373 pg/ml at baseline. A multiple linear regression analysis examined the relationship between BDNF and the predictor variables, BMI, waist-hip ratio, and memory. With an R-squared value of 0.532, the model demonstrated a strong overall fit, indicating that the predictor variables explain approximately 53.2% of the variance in BDNF levels. The adjusted R-squared value was 0.497, accounting for the number of predictors in the model. The estimate has a standard error of 266.9. The regression model was statistically significant ($F = 9.9$, $p < 0.001$), implying that the predictors collectively explain a notable proportion of the variance in BDNF. Stress showed a significant negative association with BDNF ($B = -58.46$, $p < 0.001$), implying that higher stress levels are related to lower BDNF. Short-term memory showed an insignificant negative relationship with BDNF ($B = -6.96$, $p = 0.60$), indicating that higher memory scores are linked to lower BDNF levels. BMI had a non-significant effect ($B = -8.61$, $p = 0.63$), suggesting that BMI does not substantially contribute to BDNF levels in this model. Waist hip ratio showed a significant effect (B = 2664, p = < 0.002). The results suggest that stress and waist hip ratio are substantial determinants of BDNF, while BMI and memory do not significantly contribute to its variation.

DISCUSSION

The current research aimed to find out the determinants of BDNF levels, with a particular focus on BMI, stress, waist Hip ratio, and short term memory. The findings suggest that stress is a significant predictor of BDNF while waist hip ratio also exhibits a meaningful relationship. However, short term memory and BMI do not significantly contribute to variations in BDNF levels. These results provide valuable insights into the potential physiological and cognitive factors influencing BDNF levels.

The regression analysis produced statistically significant negative correlations between stress and BDNF. This finding is in line with previous studies showing long-term stress can be damaging to neurotrophic factors, particularly BDNF, which is crucial for neuroplasticity, cognitive ability, and neuronal survival(11). Higher stress has been associated with higher cortisol release, which might downregulate BDNF expression and affect neurogenesis and synaptic plasticity(10, 11). Given the substantial correlation found in this study, maintaining ideal BDNF levels would depend critically on stress management methods, including mindfulness, physical exercise, and psychological therapies. The study demonstrated a strong correlation between waist hip ratio and BDNF, suggesting that body fat distribution could significantly determine neurotrophic levels. Although the direction and strength of this association were not stated clearly in the coefficient estimates, earlier studies have indicated that central adiposity—shown by waist hip ratio—may be connected to systemic inflammation and metabolic dysfunction, both of which can influence BDNF levels(12). Higher amounts of pro-inflammatory cytokines like TNF-α and IL-6, connected to high degrees of obesity, may cause lowered BDNF expression (13, 14). Although short term memory and BDNF were adversely associated, this link lacked statistical relevance. This suggests that although cognitive performance and BDNF levels may have a relationship in some instances, other confusing elements such as lifestyle choices, genetic factors, or neuronal efficiency could affect this link. Previous research shows that BDNF is necessary for long term memory and learning(15). The results of this study show that BDNF levels seem not to be much influenced by acute or short-term cognitive function. Rather, long-term cognitive involvement or neurodegenerative processes could have a more significant influence.

Likewise, BMI was found to have a non-significant impact on BDNF implying that general body weight by itself could not be an important determinant of BDNF levels. Although several studies have linked obesity to lower BDNF levels(13), the current results suggest that BMI alone—without regard to fat distribution, metabolic state, or other health concerns—may not give an overall picture of its effect on neurotrophic factors.

These results significantly affect knowledge of the elements controlling brain health and neurotrophic support. Particularly in groups at risk of cognitive decline, the substantial correlation between stress and lower BDNF emphasizes the importance of focused treatments to control stress properly. Moreover, the important correlation between hip-waist ratio and BDNF emphasizes the need to consider body fat distribution instead of BMI alone in evaluating metabolic effects on brain function.

As the present study is cross sectional no causality can be established and the results cannot be generalized because of relatively smaller sample size.

Future studies should incorporate more biomarkers, such as inflammatory markers, insulin resistance, and genetic variants linked to BDNF expression, to investigate the long-term effects of stress, obesity, and cognitive performance on BDNF levels. Furthermore, experimental investigations assessing the impact on BDNF levels of lifestyle changes, including exercise, dietary adjustments, and stress reduction strategies, should offer further understanding of possible therapeutic approaches.

CONCLUSION

In conclusion, this study emphasizes the importance of stress as a significant driver of BDNF. In addition, the waist-hip ratio also has a significant association with BDNF. The non-significant BMI and short-term memory results show that other variables could affect their influence on neurotrophic levels.

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